Recovery of Tomato Processing Wastes

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A method is described for producing dry press cake of good quality from tomato processing wastes. The development of a process for recovering 83% of the total waste solids from a tomato juice processing plant is reported. Costs of operation are estimated and the value of the method is described.

The average quantity of tomatoes processed annually during the period 1941 to 1950 is reported to have been 2,932,000 tons *(2)*. By far the largest part was made into juice and juice products. For every million tons of tomatoes so processed there would result about 123,800 tons of recoverable wastes having some 11,300 tons of total solids. This amounts to about 19% of the total solids in the original tomatoes.

At present only a small part of the waste solids from tomato processing is recovered. Where this is done it comprises drying only that portion of the waste which can be pressed. The disposal of tomato processing wastes is a serious problem in some areas. If they can be dried and sold for feed, it would alleviate this situation, even though the process were not profitable.

This paper describes a process developed through pilot-plant research whereby all the press cake solids can be recovered as well as 65% of the solids in the liquid wastes; enabling the recovery of 83% of the total waste solids. Since the cost of recovery will probably exceed the value of the product, such a process would be adopted only as a means of waste disposal.

PILOT-PLANT EXPERIMENTS

The wastes from a plant processing tomatoes into juice and juice products consist of culls and trimmings from the sorting operations as well as the tailings from the juice cyclones. The former contain only about 6% solids whereas the latter contain about 15%. Our work was directed toward developing a method for recovering in so far as possible all of the solids in these two types of wastes. The first step was to obtain a high solids fraction from the culls and trimmings. This was done by chopping them and passing them through a cyclone. The tailings from the cyclone have about the same solids content as the tailings from the juice making operations. The combined tailings when pressed yielded a press cake and a dilute liquor. Drying studies were first made on this press cake. Since facilities were not available at the Laboratory, the processing of culls and trimmings into tailings and liquor as well as the pressing of tailings was done elsewhere.

The equipment used for the study included a portable, two-pass, oil-fired, rotary drier of the type commonly used for alfalfa. It was 16 feet long and 7 feet in diameter with a rated evaporative capacity of 2500 pounds per hour of water when drying alfalfa at 1200° F. (649° C.). A mixing conveyor for incorporating liquids into solids was provided as well as facilities for bagging the dried product. The assembly included the necessary pumps and conveyors as well as control and recording instruments. Figure 1 shows part of the equipment.

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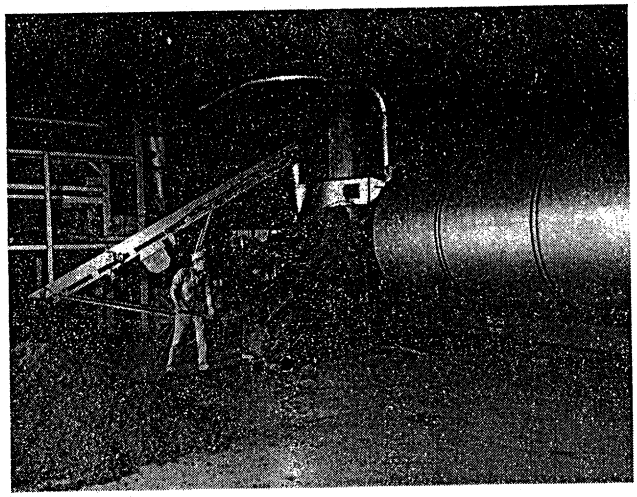

Figure 1. Experimental drying of tomato waste.

A direct-fired drier was tried since its use would not require a steam generating plant or impose an additional steam load on the tomato processing plant. Since press cake dried in direct-fired driers is at times dark in color and of reduced value, it was necessary to determine the conditions under which a high-grade product could be obtained with this type drier. Although the drier in question was capable of operating at a maximum inlet gas temperature of 1250° F. (677° C.) it was found that the maximum permissible temperature without discoloration was about 1050° F. (566° C.) with an exit gas temperature of 275° F. (135° C.). Under these conditions the capacity was about 3300 pounds per hour of press cake containing 63% moisture. This corresponds to an evaporative rate of about 2000 pounds of water per hour. These temperatures were found satisfactory for press cake varying from about 60-69% moisture, under which conditions the dried product had a good odor and light color, and contained about 8% moisture. A typical analysis of this product is shown in Table 1.

TABLE 1

Analysis of dried press cake

Ingredient	%
Moisture	8.0
Protein (N × 6.25)	22.5
Fat	14.2
Fiber	29.6
Ash	3.3
Nitrogen-free extract	22.4
Total	100.0

In a plant where the tailings from the food cyclone and from the waste cyclone are both pressed the liquid wastes from the plant will consist of press liquors as well as liquors from the waste cyclone. These combined liquors contain a little less than 5% solids. To be utilized they must be concentrated. Since facilities for concentration were not available at the Laboratory we used a concentrate prepared elsewhere. It contained about 30% solids which represents about the maximum readily obtainable by direct concentration. Following the practice sometimes used with distillers' wastes and in the citrus processing industry, attempts were made to dry a mixture of the press cake

and the concentrated liquors. It was found that although a product of satisfactory appearance could be made by drying such a mixture at an inlet temperature of 1000° F. (538° C.), exit temperature 253° F. (123° C.), only a limited amount of concentrate could be incorporated with the cake without the mixture sticking in the drier and burning locally. Using this procedure the maximum utilization of waste solids would be only about 67%.

In order to increase the amount of concentrate that could be incorporated with the press cake it was found necessary to first dry the cake. Press cake dried in the manner already described proved a satisfactory base for mixing with concentrate. By this means it was found possible to increase the amount of concentrate that could be added, thereby achieving the utilization of 83% of the solids in the wastes. Chiefly because of sugars and other solubles in the mixture it was necessary to use relatively low inlet and exit air temperatures to prevent scorching the final product. With inlet and exhaust temperatures of about 550° F. (288° C.) and 235° F. (113° C.), respectively, the drier had an evaporative rate of 798 pounds of water per hour. A typical analysis of the dried product is shown in Table 2.

TABLE 2

Analysis of dried press cake plus concentrate

Ingredient	%
Moisture	8.0
Protein (N × 6.25)	21.0
Fat	9.8
Fiber	21.9
Ash	5.9
Nitrogen-free extract	33.4
Total	100.0

Incorporation of all the concentrate in the proportions in which it would occur with respect to the press cake, gave a sticky mixture which could not be dried.

A method has been suggested whereby more or possibly all of the concentrate might be used. It would be as follows: Screen the seeds from the dried press cake and cut the screen "overs," consisting largely of skins, in a rotary knife cutter in order to expose more surface area. Recombine the cut skins and seeds, mix with the concentrate and dry in the manner previously described.

SUGGESTED COMMERCIAL OPERATION

The example given is for a waste recovery plant that will operate in conjunction with a factory making tomato juice or juice products or both. The factory is asumed to have a capacity for processing 800 tons of tomatoes in 17 hours during the peak of the season. Of course the recovery plant might obtain wastes from several factories whose combined capacities would equal 800 tons of tomatoes per day. The waste recovery plant during peak of season will produce 8.13 tons per day of high quality feed having 8% moisture. For the season, it will produce 263 tons of feed from the waste resulting from processing about 26,000 tons of tomatoes.

Figure 2 shows diagrammatically the sources and quantities of tomato wastes produced each hour during the peak of season and how these wastes are processed to make feed. It is obvious that the quantities of culls and trimmings, tailings, press cake, and liquors and their moisture contents will vary somewhat from day to day. However, the figures given here can be considered fairly typical for the area east of the Mississippi River.

Processing culls and trimmings. Culls and trimmings, containing about 94% moisture, come from the food processing plant at a rate of 7611 pounds each hour. These can be ground in a green garbage grinder

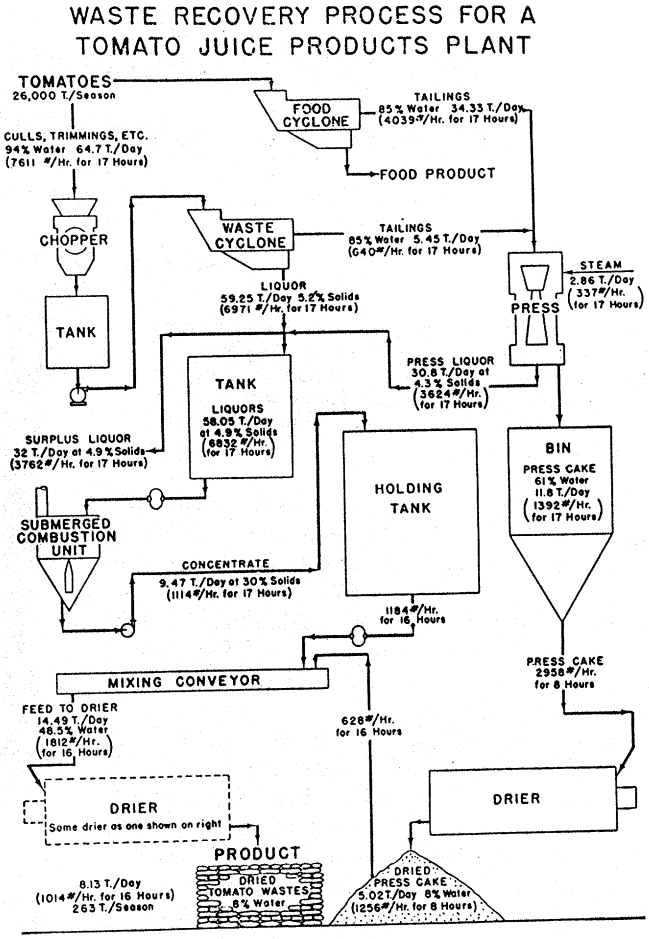

Figure 2. Waste recovery process for a tomato juice products plant.

and conveyed by means of a self-priming centrifugal pump to a small waste cyclone. This cyclone will produce 6971 pounds of waste liquor each hour containing 4.9% solids and 640 pounds of tailings at 85% moisture.

Pressing the tailings. Tailings from the waste cyclone are combined with 4039 pounds per hour of cyclone tailings at 85% moisture conveyed from the food processing plant. These can be pressed in a Zenith [b] continuous, cast-iron, screw type, pulp press equipped with stainless steel screens. Steam, at a rate of 337 pounds per hour, is injected into the waste in the press to facilitate pressing. This is the only operation in the byproducts plant where steam is used. It may be furnished by the food processing plant. The press should deliver 1392 pounds of press cake at 61% moisture and 3624 pounds of liquor at 4.3% solids per hour.

Drying the press cake. In order to efficiently utilize the capacity of the drier, the press cake produced during the 17-hour day will be dried in 7 to 8 hours. This will be accomplished by holding the press cake produced during the initial 9- to 10-hour period in a wooden bin 10 × 12 × 4.5 feet high with a sloping bottom. Press cake will be delivered from the bin to the drier by means of screw conveyor equipped with speed control at a rate of 2958 pounds per hour. A drier having the same

[b] Recommendation of this specific product is not implied. Products of other manufacturers may be equally effective.

capacity as that previously given will be satisfactory for drying the press cake.

Concentration of waste liquors. Since the waste liquors contain only about 5% solids they must be concentrated. Concentration of this material in conventional tubular evaporators poses a fouling problem. Submerged combustion is therefore suggested. The experience of others has shown that a tomato waste liquor concentrate of good color can be made by this type of evaporation. Submerged combustion units can appropriately be operated in areas where cheap natural gas is available. In the suggested installation a unit having an evaporative capacity of about 6000 pounds of water per hour will be required. A 500-gallon feed tank which will serve as a reservoir ahead of the evaporator is recommended to insure a constant feed.

During the peak of the season there will be produced hourly over and above that which can be utilized as concentrate, 3762 pounds of waste liquor of 4.9% solids. This is equivalent to about 17% of the total waste solids from the tomato processing plant. This material might be concentrated to about 30% solids and canned for use as a feed supplement for fur-bearing animals. There is a reported demand for tomato waste concentrate for that purpose. However, the cost data, reported later in this paper, do not include costs of processing this liquor.

Mixing concentrate with dry press cake. In order to produce a good final product, consisting of a dried mixture of tomato waste liquor concentrate and the previously described dry press cake, it is necessary to thoroughly coat the dried press cake with the concentrate. This can be accomplished readily in a mixing conveyor 20 feet long and 20 inches wide equipped with adjustable paddles 18 inches in diameter, and driven at about 44 r.p.m. with a 7½ HP motor. To insure thorough coating of the dried press cake with the concentrate, the paddles should be adjusted so that the materials will be held in the mixing conveyor for about 2 minutes.

Delivery of materials to the mixing conveyor at predetermined rates is required to insure their being mixed in proper proportions and to furnish a constant feed rate to the drier. For the proposed waste recovery plant, dried press cake, having 8% moisture, would be delivered into the mixing conveyor by means of a variable speed screw conveyor at a rate of 628 pounds each hour for 16 hours. Simultaneously, the concentrate, having 30% solids, would be pumped into the mixer by means of a positive delivery pump at 1184 pounds an hour. A screw conveyor (not shown) is used to transport the mixture to the drier.

Drying the mixture. Large-scale drying studies in the previously described rotary, direct-fired drier, showed that a mixture of concentrate having 30% solids and dried press cake could be dried to produce a satisfactory product when the mixture did not contain more than about 65% concentrate. For the proposed tomato waste factory, it is necessary to evaporate 800 pounds of water each hour from 1812 pounds of mixture for 16 hours during the peak of the tomato season. Hence the previously described drier has sufficient capacity to dry the mixture of concentrate and dry press cake. It will produce 8.13 tons of product each day and 263 tons each season. Since the drier can readily process the wet press cake in 7 to 8 hours, and can dry the mixture of concentrate and dry press cake in 16 hours, it is apparent that the same drier can dry both materials on a three-shift basis during the peak of the season.

COSTS

For purposes of cost estimation the proposed waste recovery plant is asumed to operate in conjunction with an existing tomato processing plant located in Indiana, the existing plant having a capacity of 26,000 tons of tomatoes in an 8-week season. It is assumed that for the new enterprise land, roads, railroad siding, and the relatively small amount of steam required, are available. It is further assumed that the wastes from the processing plant will be conveyed to the recovery plant. The waste recovery plant will operate 550 hours per year. At the peak of operation it will produce 8.13 tons per day. The total seasonal output would be 263 tons. Since operations are carried out only during the summer, housing will consist of a structure comprising a concrete floor, no walls and a corrugated galvanized roof. Fuel for both the submerged combustion unit and the drier will be natural gas.

The total fixed capital required would be about $88,500 which figure includes the building, all equipment installed, engineering fees, and contingencies. With an additional $25,000 working capital, the total capital required for the enterprise would be $113,000. The cost to make a ton of the dried product would be about $116. This includes not only materials, labor and factory overhead, but interest on working capital, administration and general expense as well as all other items that should comprise a complete cost estimate. Further details regarding any items of cost may be had from the authors.

Templeton *(1)*, in 1947 mentions $65.00 a ton as the sale price of dried press cake alone. The value of dried press cake containing concentrate cannot be stated pending conclusion of current feeding tests with broilers and dogs. However, it is thus far apparent that the product in poultry rations is at least equal to wheat middlings. At $75 a ton for wheat middlings, the difference between cost to make and the value of the product is $41 a ton. Expressed as the cost of waste disposal this amounts to $10,780 a year or approximately three-quarters of a cent per case of tomato juice. In an area where dumping is no longer possible, a tomato processing plant may well be faced with a choice between going out of business or providing sewage disposal facilities. In such a situation the recovery procedures suggested here may represent the cheapest means of disposal.

SUMMARY AND CONCLUSIONS

It is well established that the disposal of tomato processing wastes is a serious problem in certain areas.

Some plants now recover part of the waste in the form of dry press cake, and there has been a ready market in the east for this material when it is of good

quality. A method is here described for producing a good product by drying press cake in a direct-fired, rotary alfalfa drier.

There is also described the development of a process whereby 83% of the total waste solids from a tomato juice or juice processing plant can be recovered. It consists in drying a mixture of dry press cake and concentrate made from the waste liquors. Feeding tests are now being made to establish its value as a feed supplement for broilers and dogs.

At an assumed value of $75 a ton for the product, the waste disposal cost would be $10,780 per year or about three quarters of a cent per case of tomato juice. This would probably be less than the cost to eliminate the wastes by sewage disposal.

LITERATURE CITED

1. Templeton, C. W. Cost studies on dehydrating tomato wastes. *Food Packer,* 28, 53 (1947).
2. United States Department of Agriculture Agricultural Statistics 1951, page 265.